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United States
Environmental Protection
Agency

Health Effects Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S1-81-027 Apr. 1981

EPA

Project Summary

Health Effects of Swimming in Lake Pontchartrain at New Orleans

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This two-year study measured health effects of swimming in marine recreational waters in a subtropical climate by testing the association between reported post-swim symptom rates and density of bacterial indicator organisms. The study replicated previous investigations conducted at beaches in temperate climates. Variation in water quality at the same site provided bacterial exposure levels for swimmers. Data were obtained from approximately 5400 swimmers and 2300 nonswimmer controls over the two years.

Indicators studied the first year were *E. coli, Klebsiella, Pseudomonas aeruginosa,* fecal coliforms, and enterococci. The first four organisms followed relatively the same concentration pattern while there was an inverse relationship between *E. coli* and enterococci after rainfall. For children under age 10 a significant positive association was found between gastrointestinal symptom rates and exposure to *E. coli* levels above 200/100 ml. No association was noted for enterococci. For older persons, age 10 and over, evidence of a relationship between symptoms and enterococcus density was strongly suggested.

The second year study focused on the relationship of *E. coli* and enterococcus levels with swimmer illness. Bacteria counts were considerably lower, especially *E. coli* levels. First year results were partially substantiated in that illness rates were again higher for swimmers than nonswimmers and highest for young swimmers. No association, however, was found between either microbial indicator and symptom rates for children. For the older group there appeared to be an interaction effect of *E. coli* and enterococcus levels with symptoms rates. Study of a small sample of swimmers at a less polluted site on the same lake (i.e., very low *E. coli* and equivalent enterococcus densities) corroborated the second year findings by age.

In both years a relationship between enterococcus density and gastrointestinal symptom rates in swimmers over age nine established the importance of this indicator as a criterion of swimming water quality. Nonconsistent findings for children with respect to *E. coli* do not rule out the importance of this indicator but suggest perhaps a criterion level that could not be adequately tested in the second year.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

As part of the national program to develop health effects criteria for

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marine recreational waters, the U.S. Environmental Protection Agency (EPA) in 1973 through 1975 conducted prospective epidemiological-microbiological studies at bathing beaches at Coney Island and The Rockaways, New York. The overall purpose of the New York beach studies was, in the first year, to test methodology designed to overcome limitations of past research to measure health effects of swimming in recreational waters near cities, and in the second year, to replicate the study for corroboration of findings from the first year's satisfactory methodological experience. The combined results of the two studies along with those of the third year were for the purpose of developing a data base relating illness as measured by symptomatology to some potential microbial indicators of water quality. In New York the health effects of swimming at a "barely acceptable" (BA) site were compared to those from a control "relatively unpolluted" (RU) site. At each site symptom rates for nonswimmers were used as the baseline measure against which to compare health effects attributable to water exposure.

In general, the results showed that the rates for broad categories of symptoms (gastrointestinal, respiratory, other, and disabling) were higher for swimmers than nonswimmers at both the BA and RU beaches. The differentials in rates (swimmers to nonswimmers) were higher at the BA site. The only statistically significant difference, however, was for combined gastrointestinal symptoms at the BA beach. This difference appeared to be attributable largely to higher reported rates of Hispanic-American and young (under age 20) swimmers at Coney Island (the BA site) than their counterparts at Rockaways (the RU site).

In attempts to demonstrate a relationship between indicator density and symptomatology, *Escherichia coli* and fecal streptococci appeared to be the most promising among several indicators that were examined.

A third phase of the national program was to replicate the study procedure at some subtropical site for the purpose of verifying or expanding the relationship between microbial indicators and reported symtomatology obtained in the New York study. Further, it was hoped that a mathematical model could be developed and tested on data obtained from these geographically distinct but representative locations.

Following the pretesting of conditions at beaches near two southern cities in 1976, a popular site on Lake Pontchartrain at New Orleans was selected for study in Summer 1977. Pretests indicated that replication of the epidemiological procedures of the New York study was feasible in terms of size of the beach-going population, its sociodemographic mix, and response rate. New Orleans did not provide, however, two distinctive bathing sites with respect to pollution level. The lake at this site was noted for almost day-to-day variation in fecal streptococci and fecal coliform densities, having been tested for a number of years by the City Health Department. The variation appears to be associated primarily with rainfall, an association that is so consistent that the Health Department abandoned an earlier practice of posting the beach "closed" on days when counts were high in favor of a permanently posted warning that "the water. . . .is subject to intermittent pollution, especially after heavy rainfall."

The association between fecal coliform count and rainfall is attributed to the city's low-lying position, the high water table, and soil-settling characteristics. In Orleans Parish (county) the sewerage system is below river level and ordinarily pumped into the Mississippi River south and east of the city. Because of differential settling, the pipes become cracked and broken. During heavy rains as the ground becomes saturated, there is infiltration from sewage to drainage lines. To prevent flooding the excess water must be pumped out through canals. One such canal is the Orleans Outfall Canal through which water is pumped out into Lake Pontchartrain at a point approximately 1200 yards from Levee Beach, the site chosen for study. From contiguous Jefferson Parish, however, sewage is discharged into the Lake at several points, the nearest being about 2.5 miles from the beach. The flow from that point is in the general direction of the beach.

Given the noted variation in microbial levels, plus climatological data for the past few years showing periods of dry and wet weather during each summer, it appeared reasonable to assume that in any given year the one site would provide both "experimental" and "control" conditions for measuring health effects associated with swimming in subtropical recreational waters under different levels of pollution.

For the New Orleans study, the number of indicators was limited to five: *E. coli, Klebsiella, Pseudomonas aeruginosa*, fecal coliforms, and enterococci.

Testing conditions the first year proved satisfactory. Promising techniques for measuring individual exposure to water conditions defined by indicator density were developed, and results with respect to swimmer-nonswimmer differential symptom rates and relationships between symptoms and indicator levels tended to corroborate the findings of the New York study.

The study was repeated the following year, summer 1978, using the same procedural design, at the same site, but limiting the indicators to *E. coli, Klebsiella*, and enterococci. A major unanticipated change in water conditions was observed the second year, however. There was considerably less variation in and lower levels of indicator densities, and the relationship of the indicators differed from one year to the next, particularly *E. coli* and enterococci. This effect was apparently attibutable to "natural" causes since no changes had occurred in sewage disposal or storm water runoff provisions for the city. The month prior to study, however, ten inches of rain had fallen on the city in the matter of a few hours which may have had a cleansing effect.

In the second year, also, the attempt was made to study a second site on the opposite side of the lake known to be less polluted.

Conclusions and Recommendations

The results of this study measuring health effects of swimming in relation to specific indicator organisms present in the subtropical water of Lake Pontchartrain are as follows:

Rates of swimmers were generally higher than rates for nonswimmers for a variety of symptoms, including gastrointestinal, respiratory, eye-ear-nose, and other. For gastrointestinal symptoms the swimmer rates were consistently significantly higher. Diarrhea was the most frequently reported specific symptom among swimmers.

Children under age 10 who swam showed the highest gastrointestinal symptom rate (12 percent) and the greatest swimmer-nonswimmer difference (six percent). The symptom rate for

swimmers age 10 and over was approximately eight percent and the swimmer-nonswimmer difference three percent.

In the second year, statistically significant rate differences were found between swimmers and nonswimmers in the older but not the younger age group for symptoms other than gastrointestinal. The rates for older and younger swimmers were essentially the same, but the rates for young nonswimmers were higher than the rates for older nonswimmers, resulting in a considerably smaller swimmer-nonswimmer difference for the young. The disparity in these findings by age suggests that the etiological agents for these symptoms are not necessarily water-related. The consistent significant findings both years for gastrointestinal symptoms regardless of age, however, is evidence for the argument of the presence of microbial agents in Lake Pontchartrain that are associated with these types of complaints.

Investigation of the relationship between microbial indicators and symptomatology strongly suggests different importance of two indicators *E. coli* and enterococci, by age. A significant association between *E. coli* density above 200/ml. and gastrointestinal symptom rates for children was found the first year. This, however, was not substantiated the second year, perhaps because *E. coli* densities only slightly above this level were found on only three of the 12 trial days. The absence of an enterococcus effect either year for children is viewed as important for further substantiation. A positive relationship between enterococcus density and gastrointestinal symptoms for the older age group appeared in the findings both years, either independently or in interaction with *E. coli*.

Lake Pontchartrain is probably more unique than typical of a marine recreational bathing site in the subtropical region, hence generalizations of the findings to other such sites may not be appropriate. However, analysis of the relationships between indicators and symptomatology is not necessarily specific to a situation. The day-to-day and often hour-to-hour variation in water quality at this site presented a challenge in measurement of exposure. Although a number of methods were attempted, the principal technique, in terms of indicator density by day, time, and place of swimming for each individual, has not been used in other studies. This lack of uniformity in exposure measurement hampers precise comparison of results from studies done elsewhere, especially with respect to suggested thresholds of exposure. Conclusions from this and other studies are consistent with respect to the importance of *E. coli* and enterococci as agent indicators and the greater vulnerability of children. The differential importance of each indicator by age found in this study warrants further investigation.

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The complete report, entitled "Health Effects of Swimming in Lake Pontchartrain at New Orleans," (Order No. PB 81-178 741; Cost: $6.50, subject to change) will be available only from:
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• U.S. GOVERNMENT PRINTING OFFICE: 1981 757-012/7058

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